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GB 1435457 A US 5399097 A US 4846712 A
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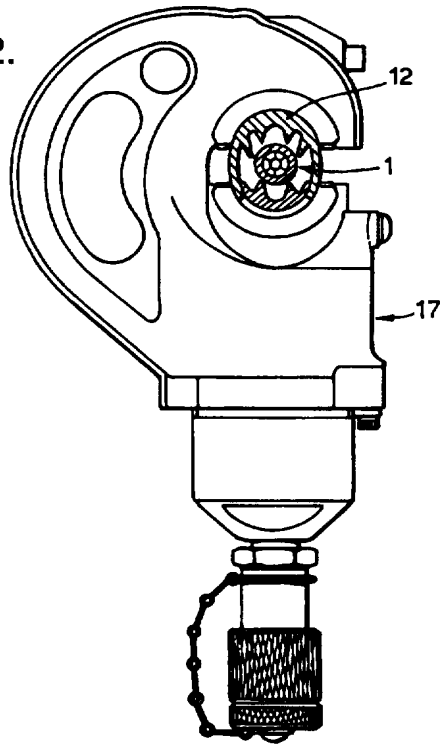
(54) Lockable insulation piercing connectors

(57) The connector comprises relatively movable parts, at least one of which includes at least one sharp formation shaped and dimensioned so that when the parts are assembled around an insulated metallic conductor of corresponding dimensions and urged together the sharp formation will penetrate the insulation and contact the metallic conductor without any substantial deformation of either the metallic conductor or the sharp formation and at least one of which includes a formation that is deformable to lock the parts in position after they have been urged together.

Fig.2.



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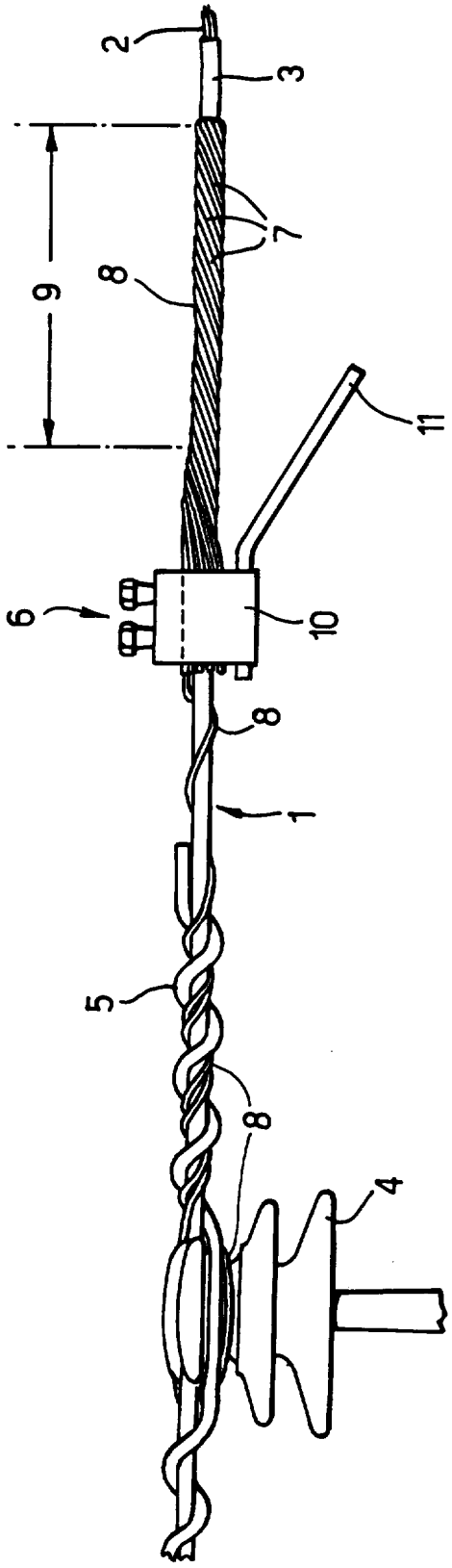


Fig.1.

Fig.2.

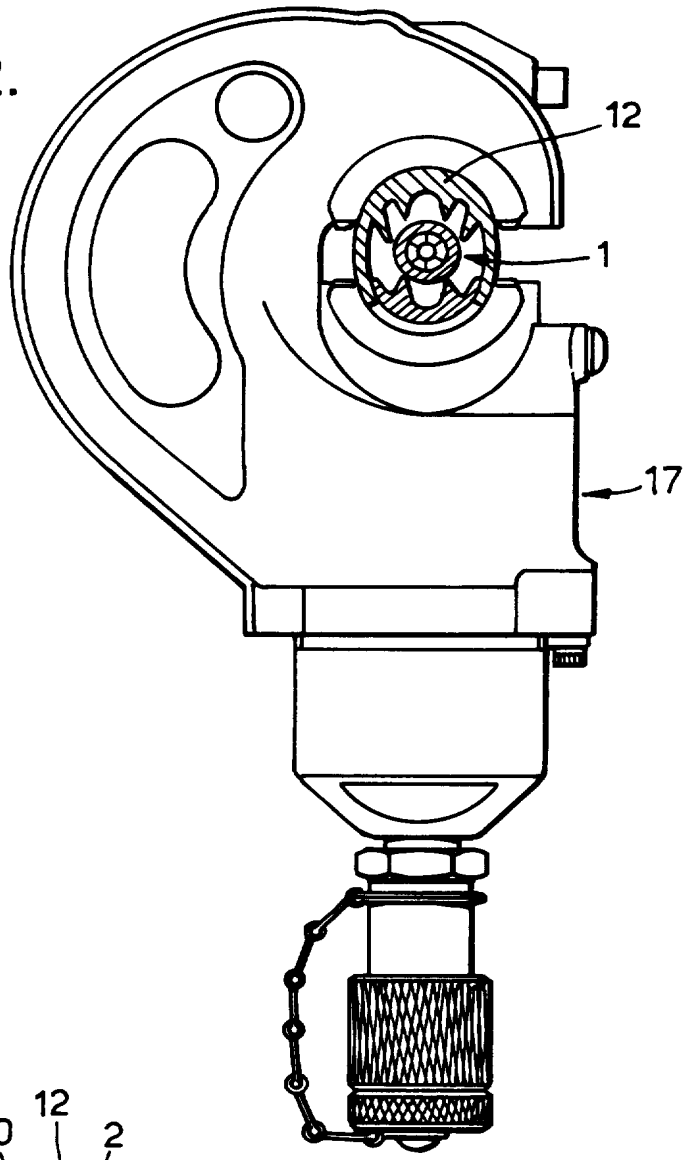
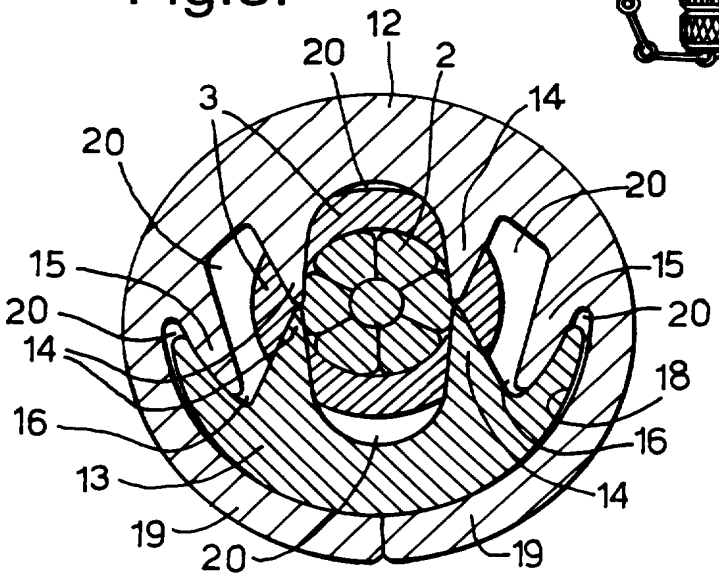


Fig.3.



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Electric Connectors

This invention relates to electric connectors which are primarily intended for use in fittings for electric overhead lines, though they may also be used for other purposes (for example in cable joints).

In another application filed today (application no. GB95 , agent's ref. zz0064CPC/PLPp) we have described and claimed certain fittings in which the connectors of the present invention are preferably used.

These fittings are primarily intended for lines operating at potentials appropriate to secondary high-voltage distribution, that is at around 5-25kV, in current United Kingdom practice meaning mainly lines operating at 11kV.

Such distribution lines have in the past usually incorporated bare conductors, but it is increasingly the practice to use insulated conductors to reduce frequency of transient faults due to wind-borne debris, birds and squirrels, to provide better (but not total)protection from accidents and to reduce need for clearance from trees. Such improvements, however, bring new problems and in particular the use of insulated conductors makes it difficult to ensure that the line is dead (earthed or in North American terminology grounded) prior to fitment of a circuit main earth to the conductor to enable hands-on work to be carried out on the line; it also increases susceptibility to damage from induced overvoltages arising from lightning or other causes.

A need has therefore arisen for fittings providing access for an earth bonding conductor and/or for arcing phase-to-phase in case of overvoltage to limit damage to the conductor and/or to other parts of the line, and the

application referred to provides fittings that comprise an insulation-piercing connector to be mounted on the insulated conductor and make effective electrical contact with it and a plurality of helically preformed rods of sufficiently conductive metal to be wrapped around a portion of the insulated conductor and connected at one end to the said connector.

The insulation-piercing connector may perform no function except that of connecting the preformed rods to the line conductor, but it can also perform (either by itself or in conjunction with other components) at least one additional function selected from

- connecting and supporting an arcing horn;
- connecting a tapping conductor;
- supporting a bail by which a tapping conductor can be subsequently connected; and
- connecting a trace wire for bringing the line voltage to the surface of an adjacent insulator.

The insulation-piercing connector needs to make a contact with the line conductor that is capable not merely of bringing the fitting to line potential, but also of carrying the maximum fault current of the line for a period sufficient for protective circuit breakers to operate, and if the fitting is to be used directly or indirectly to make tapping connections of carrying the maximum applicable load current for an indefinite period; and it must do this without substantially reducing the tensile strength of the conductor or creating local concentrations of tensile or bending forces that might lead to fatigue failures. It is desirable it should have a smooth external shape of small diameter.

The connector of the present invention meets these

needs and comprises relatively movable parts, at least one of which includes at least one sharp formation shaped and dimensioned so that when the parts are assembled around an insulated metallic conductor of corresponding dimensions and urged together the sharp formation will penetrate the insulation and contact the metallic conductor without any substantial deformation of either the metallic conductor or the sharp formation and at least one of which includes a formation that is deformable to lock the parts in position after they have been urged together.

Preferably there are at least two such sharp formations constituting a pair spaced and positioned to receive the metallic conductor as a force fit between them. Preferably each of the two parts bears such a pair of sharp formations (or if desired more than one pair, spaced longitudinally).

The parts may be urged together by a conventional compression tool of the kind used to make "crimped" electrical connections, but the connector differs from such conventional crimped connections in that the contact-making formations are not to be substantially deformed when they are urged together, and the compressive movement will not normally be such as to produce a solid metal cross-section — insulation material and even air space may (and normally will) remain within the connector.

Preferably the or each formation that is deformable to lock the parts together is a flange on one of the parts that is wrapped round the exterior of the other part as they are urged together. Preferably there are two such flanges on the same part which wrap around the other part in opposite directions.

Preferably at least one of the connector parts includes a formation (or preferably a pair of formations) shaped and positioned to engage the insulated conductor before the parts are urged together to ensure correct positioning of the insulated conductor between the connector parts (centring).

Preferably the connector parts include mating formations shaped to ensure correct relative positions at least when they have been fully urged together. In a preferred such arrangement, there are mating ribs and grooves on opposite sides of the parts and the remaining mating surfaces are arcuate so that if one rib bottoms in its groove while the parts are being urged together the result will be relative rotation in the direction tending to bottom the other rib in its groove.

Preferably the same ribs fulfil the functions described in both of the preceding two paragraphs.

When the connector is used in the fittings of the other application referred to above, the preformed rods and/or other members to be connected to the line conductor by the insulation-piercing connector may be urged into contact with its external surface by a separate clamp.

The invention will be further described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a sketch of an complete overhead line fitting of the kind referred to, shown in position on an insulated overhead line and with an associated support insulator;

Figure 2 is an enlarged sectioned end view of an insulation-piercing connector in accordance with the

invention forming part of this fitting, shown with its parts assembled in a conventional compression tool and ready for its parts to be urged together; and

Figure 3 is an enlarged sectioned end view of the connector after its parts have been urged together and locked in position on the insulated line conductor and the tool removed.

The part of the installation seen in figure 1 comprises a line 1 consisting of a metallic conductor 2 and insulation 3 supported by an insulator 4, to which it is secured by a preformed rod 5 made of semiconductive carbon-loaded polymer in known way. Adjacent to the insulator 4 is mounted a connector assembly including an insulation-piercing connector (not visible in this Figure), a number of helically preformed rods 7...7 made of the aluminium alloy grade 6061 and an additional preformed rod 8 of EC grade aluminium which is extended to form a trace wire extending around the insulator 4.

The rods 7...7 and 8 together form a close-fitting and substantially complete layer around the line 1 over the length 9. The ends of the rods 7 and an intermediate part of rod 8 contact the outer surface of the insulation-piercing connector and are secured to it by a conventional mechanical connector clamp 10 of the sliding-bridge type. This also secures an arcing horn 11 (which co-operates with the corresponding arcing horn of a similar fitting on an adjcent phase conductor to provide a current-path in the event of overvoltage sufficient to strike an arc, whether induced by lightning or from some other cause), or it might also (or instead) support a bail conductor for making a tapping connection.

Turning now to Figures 2-3, the insulation-piercing connector comprises a first part 12 and a second part 13 which are initially a loose sliding fit with one another. Each of the parts 12 and 13 has a pair of sharp-edged insulation-piercing rib formations 14...14 (best seen, and referenced, in Figure 3), spaced apart so that the metallic conductor 2 of the line will fit between them tightly but without any substantial deformation either of the ribs or of the conductor and with heights such that they nearly meet each other when the parts are fully assembled. The first part 12 also has a second pair of ribs 15, which are blunt and have two distinct funtions: on initial assembly (Figure 2) they act as guides spaced apart about the diameter of the insulation on the line 1 to ensure that it is centrally located between the insulation-piercing ribs 14, and while the parts are being urged together by operation of the compression tool 17 they co-operate with mating grooves 16 in the second part 13 to ensure correct relative positioning of the parts in respect of rotation in the plane of the figures; if the parts are relatively rotated, one of these ribs 15 will reach the bottom of the corresponding mating groove 16 before the connector is fully compressed and further operation of the tool 17 results in sliding movement about the arcuate contacting surfaces 18 until a substantially symmetrical position is established.

The first part 12 of the insulation-piercing connector also includes two longitudinally-extending flanges 19...19 which are initially inturned just sufficiently to engage the second part 13 but which during the operation of the compression tool become wrapped round the part 13 and substantially enclose it.

Preferably the insulation-piercing connector is provided with a greasy medium for protecting the connection from ingress of moisture, in a quantity at least sufficient to fill the void spaces 20 remaining when the parts are fully assembled. The first part may be provided with axial extensions from which the ribs 14...14, 15...15 have been removed and which are internally grooved to receive a resilient ring to assist in excluding moisture. It will be appreciated that the resilient ring needs to be split to allow assembly over the line conductor 1.

The length 9—9 of the wrapped preformed rods (Figure 1) is in most respects equivalent to a length of bare conductor, and can be used to verify that the line is dead or to apply a temporary circuit main earth, a permanent tapping connector, or indeed almost any fitting that could be applied to a bare conductor. Such fittings, and the tools used to apply and/or remove them, are supported through the preformed rods and do not apply forces to the insulation-piercing connector that might disturb it and put the security of its connection at risk.

If desired, the whole or any part of the fitting, excluding the arcing horn if present, may be fitted with a removable shroud of flexible insulating material as additional protection from accidental contact.

CLAIMS

1 An insulation-piercing connector comprising relatively movable parts, at least one of which includes at least one sharp formation shaped and dimensioned so that when the parts are assembled around an insulated metallic conductor of corresponding dimensions and urged together the sharp formation will penetrate the insulation and contact the metallic conductor without any substantial deformation of either the metallic conductor or the sharp formation and at least one of which includes a formation that is deformable to lock the parts in position after they have been urged together.

2 A connector as claimed in claim 1 in which there are at least two such sharp formations constituting a pair spaced and positioned to receive the metallic conductor as a force fit between them.

3 A connector as claimed in claim 2 in which each of the two said parts bears at least one such a pair of sharp formations.

4 A connector as claimed in any one of claims 1-3 in which the or each formation that is deformable to lock the parts together is a flange on one of the parts that is wrapped round the exterior of the other part as they are urged together.

5 A connector as claimed in claim 4 in which there are two such flanges on the same part which wrap around the other part in opposite directions.

6 A connector as claimed in any one of claims 1-5 in which at least one of the connector parts includes a formation shaped and positioned to engage the insulated conductor before the parts are urged together to ensure

correct positioning of the insulated conductor between the connector parts.

7 A connector as claimed in claim 6 in which the said one of the connector parts includes a pair of such formations.

8 A connector as claimed in any one of claims 1-7 in which the connector parts include mating formations shaped to ensure correct relative positions at least when they have been fully urged together.

9 A connector as claimed in claim 8 in which there are mating ribs and grooves on opposite sides of the parts and the remaining mating surfaces are arcuate so that if one rib bottoms in its groove while the parts are being urged together the result will be relative rotation in the direction tending to bottom the other rib in its groove.

10 A connector as claimed in claim 7 in which the said formations are also shaped to ensure correct relative positions of the connector parts at least when they have been fully urged together.

11 A connector as claimed in claim 10 in which he said formations are mating ribs and grooves on opposite sides of the parts and the remaining mating surfaces are arcuate so that if one rib bottoms in its groove while the parts are being urged together the result will be relative rotation in the direction tending to bottom the other rib in its groove.

12 An insulation-piercing connector substantially as described with reference to and as shown in Figures 2-3.

The Patent Office

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Claims searched: 1-12 **Date of search:** 7 January 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H2E (EPGP,EPGT,EPSR,EPSS,EPSV,EPX)

Int Cl (Ed.6): H01R

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 1 435 457	(AMP)	
A	US 5 399 097	(Yazaki)	
A	US 4 846 712	(Dayco)	
A	US 4 291 934	(Communications Technology)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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EUR-CL (EPC): H01R011/14 , H01R009/03